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## SPECIFICATION

### ANTIFUNGAL MEDICINAL COMPOSITIONS

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#### Technical Field

The present invention relates to a medicinal composition, and more specifically to a medicinal composition useful in the treatment and prevention of  
10 fungal diseases.

#### Background Art

Fungal diseases represented by athlete's foot,  
15 vaginal candidiasis, and so on were formerly the diseases difficult to be completely cured, so the treatment of athlete's foot has been a theme of eternity.

In recent years, bifonazole and other various drugs such as butenafine and terbinafine have been developed,  
20 allowing general cutaneous fungal diseases such as athlete's foot to be completely cured. Among the fungal diseases, however, one invaded in the thickened or excessively keratinized portion of a nail or skin remains almost impossible to be treated with the  
25 external application of a drug because of the difficulty of allowing the drug to be transdermally delivered to

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that portion. Therefore, the treatment of such a fungal disease has been only conducted by means of a method involving orally administering an antifungal agent such as terbinafine for as long as several months. Such oral  
5 administration is systemic, so it will involve a great economic burden when it is prolonged. Besides, the above administration has been difficult to be applied on tinea unguium having a little influence on a human life because of an increase in possibility of causing side  
10 effects or the like.

In other words, the conventional method has been insufficient to be applied as a therapeutic procedure with external administration of a drug on a fungal disease invaded in the bottom portion of thick keratin  
15 such as the inside of a thickened or extensively keratinized portion of a nail or skin. Therefore, development of a medicinal composition useful for an external treatment of the fungal disease invaded in the bottom portion of such thick keratin has been demanded.

20 On the other hand, the compound represented by the general formula (1) to be described latter has been known to have an antifungal action. However, no technology, which utilizes such a compound as a principal ingredient to prepare an antifungal  
25 preparation for tinea unguium or for tinea in the thickened portion of heel or the like, has been known in

the art at all.

Furthermore, no idea for obtaining an antifungal medicinal composition by combining the antifungal compound represented by the general formula (1) and a  
5 specific film-forming agent or a water-soluble plasticizer in the form of a solid or paste at 20°C at 1 atm has been known in the art at all. Besides, the fact that the antifungal medicinal composition composed as described above will be useful in the treatment of tinea  
10 unguium and the fungal diseases in the excessively keratinized portion or thickened portion of the skin has not been known at all.

#### Disclosure of the Invention

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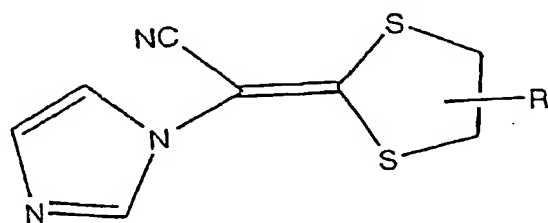
The present invention has been made under such circumstances and intends to provide a medicinal composition useful for external application in the treatment of a fungal infection reaching the lower part  
20 of a thick keratin layer.

In consideration of such circumstances, the inventors of the present invention have dedicated efforts to the study of obtaining a medicinal composition useful for external application in the  
25 treatment of a fungal infection reaching the lower part of a thick keratin layer. Consequently, the inventors

of the present invention have completed the present invention by finding out that an antifungal medicinal composition characterized by including (1) a film-forming agent, (2) a water-soluble plasticizer in the form of a solid or a paste at 20°C at 1 atm, and (3) an antifungal compound represented by the following general formula (1) exert such characteristics.

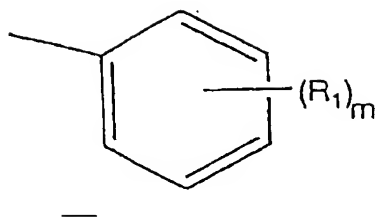
In other words, the present invention is constructed as described below.

(1) An antifungal medicinal composition, comprising: (1) a film-forming agent; (2) a water-soluble plasticizer in the form of a solid or a paste at 20°C at 1 atm; and (3) an antifungal compound represented by a general formula (1) and/or a physiologically acceptable salt thereof.



... (1)

(In the formula, R represents an alkyl group having 1 to 8 carbon atoms, a cycloalkyl group having 3 to 6 carbon atoms, a methylene group, a lower alkenyl group, a halogen atom, a lower alkyl group substituted with a lower alkoxy group or a lower alkylthio group, or a group represented by a general formula (2) below.)



... (2)

(In the formula,  $R_1$  represents a hydrogen atom, a  
 5 halogen atom, a linear- or branched-chain lower alkyl  
 group, a lower alkoxy group, a haloalkoxy group, or a  
 methylenedioxy group, and  $m$  represents an integral  
 number of 1 to 3.)

(2) The antifungal medicinal composition according to  
 10 (1), wherein the firm-forming agent has low water  
 solubility or water insolubility.

(3) The antifungal medicinal composition according to  
 (2), wherein the film-forming agent having low water  
 solubility or water insolubility comprises one or two or  
 15 more selected from the group consisting of ethyl  
 cellulose, hydroxypropyl methylcellulose phthalate, and  
 an acrylic resin emulsion.

(4) The antifungal medicinal composition according to  
 (2), wherein the film-forming agent having low water  
 20 solubility or water insolubility comprises ethyl  
 cellulose.

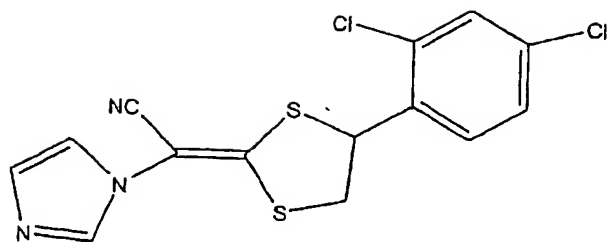
(5) The antifungal medicinal composition according to  
 any one of (1) to (4), wherein the water-soluble

plasticizer in the form of a solid or a paste at 20°C at 1 atm comprises a compound having a polyoxyethylene group and/or a polyoxypropylene group.

(6) The antifungal medicinal composition according to 5 (5), wherein the water-soluble plasticizer in the form of a solid or a paste at 20°C at 1 atm comprises an oxyethylene oxypropylene copolymer.

(7) The antifungal medicinal composition according to (5), wherein: the film-forming agent having low water 10 solubility or water insolubility comprises one or two or more selected from the group consisting of ethyl cellulose, hydroxypropyl methylcellulose phthalate, and an acrylic resin emulsion; and the water-soluble plasticizer in the form of a solid or a paste at 20°C at 15 1 atm comprises a polymer or a copolymer of oxyethylene and/or oxypropylene, and has a polymerization degree of 70 or more.

(8) The antifungal medicinal composition according to any one of (1) to (7), wherein the compound represented 20 by the general formula (1) comprises (E)-[4-(2,4-dichlorophenyl)-1,3-dithiolan-2-ylidene]-1-imidazolyl acetonitrile (Compound 1).



(Compound 1)

(9) The antifungal medicinal composition according to any one of (1) to (8), further comprising a surfactant.

5 (10) The antifungal medicinal composition according to (9), wherein the surfactant comprises an anionic surfactant.

(11) The antifungal medicinal composition according to (10), wherein the anionic surfactant comprises alkyl sulfate which may have a polyoxyethylene group and/or alkyl phosphate which may have a polyoxyethylene group.

10 (12) The antifungal medicinal composition according to any one of (1) to (11), further comprising acetone or methyl ethyl ketone as an organic solvent.

15 (13) The antifungal medicinal composition according to any one of (1) to (12), wherein a coating film having plastic property is formed when the antifungal medicinal composition is applied to an application target.

(14) The antifungal medicinal composition according to 20 (13), wherein the coating film having plastic property shows a glass state having viscosity.

(15) The antifungal medicinal composition according to

(13) or (14), wherein the antifungal medicinal composition is capable of recoating.

(16) The antifungal medicinal composition according to any one of (13) to (15), wherein the coating film of the  
5 antifungal medicinal composition is removable with swelling means using an aqueous solvent and means for physical scratching.

(17) The antifungal medicinal composition according to any one of (13) to (16), wherein the antifungal  
10 medicinal composition is used for an extensively keratinized portion of skin or nail or a skin-thickened portion around foot as an application target.

(18) A method of producing an antifungal medicinal composition having (1) one or two or more selected from  
15 the group consisting of ethyl cellulose, hydroxypropyl methylcellulose phthalate, and an acrylic resin emulsion, (2) a polymer or copolymer of oxyethylene and/or oxypropylene, and (3) an antifungal compound represented by a general formula (1) and/or a physiologically  
20 acceptable salt thereof, comprising:

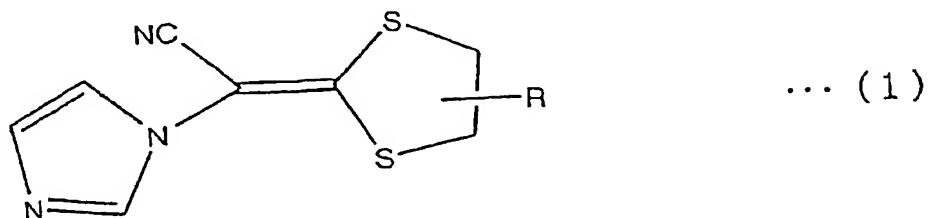
dissolving alkyl sulfate which may have a polyoxyethylene group and/or alkyl phosphate which may have a polyoxyethylene group and the polymer or copolymer of oxyethylene and/or oxypropylene in a  
25 solvent containing acetone or methyl ethyl ketone;

adding and dissolving in the solution the one or

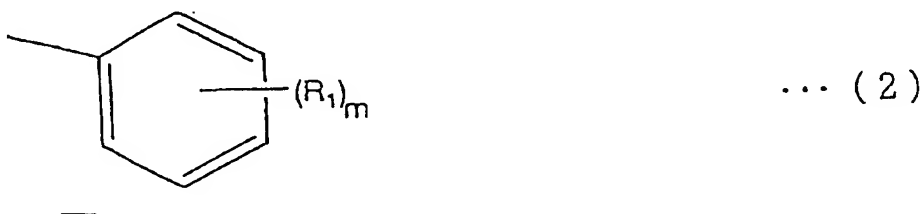


two or more selected from the group consisting of ethyl cellulose, hydroxypropyl methylcellulose phthalate, and an acrylic resin emulsion; and

adding and dissolving in the solution the  
 5 antifungal compound represented by the general formula (1) and/or the physiologically acceptable salt thereof.



10 (In the formula, R represents an alkyl group having 1 to 8 carbon atoms, a cycloalkyl group having 3 to 6 carbon atoms, a methylene group, a lower alkenyl group, a halogen atom, a lower alkyl group substituted with a lower alkoxy group or a lower alkylthio group, or a  
 15 group represented by a general formula (2) below.)



(In the formula, R<sub>1</sub> represents a hydrogen atom, a  
 20 halogen atom, a linear- or branched-chain lower alkyl

group, a lower alkoxy group, a haloalkoxy group, or a methylenedioxy group, and m represents an integral number of 1 to 3.)

5                    Brief Description of the Drawings

Fig. 1 is a diagram showing a sample charge of a Franz type cell.

Fig. 2 is a diagram representing the results of  
10    Example 6.

Best Mode for carrying out the Invention

Hereinafter, the present invention will be  
15    described in detail.

The antifungal medicinal composition of the present invention is characterized by including (1) a film-forming agent, (2) a water-soluble plasticizer in the form of a solid or a paste at 20°C at 1 atm, and (3) an  
20    antifungal compound represented by the general formula (1) and/or a physiologically acceptable salt thereof.

The film-forming agent in the antifungal medicinal composition of the present invention may be one generally used for medicinal compositions or the like,  
25    and preferable examples thereof include one insoluble or poor soluble in water.

Here, the term "insoluble or poor soluble in water" means that the saturated concentration of an agent is about 1 g/10 L, preferably 1 g/50 L or less with reference to water at  $20 \pm 5^{\circ}\text{C}$ .

5        Preferable examples of such a film-forming agent include: alkyl celluloses represented by ethyl cellulose and hydroxypropyl methylcellulose phthalate; and acrylic resin-based emulsions such as one commercially available from Higuchi Shokai Co., Ltd. by the name of Eudragit  
10        (registered trademark) NE30D, which is a dispersion liquid of ethyl acrylate/methyl methacrylate copolymer. Each of them may be independently used, or two or more of them may be used in combination. The use of ethyl cellulose alone of those is particularly preferable.

15        A preferable content of the film-forming agent in the antifungal medicinal composition of the present invention is preferably 0.1 to 10% by weight in volume, more preferably 0.3 to 5% by weight in volume in total with respect to the whole amount of the medicinal  
20        composition. This is because a coating film having a sufficient strength cannot be obtained when the amount of the film-forming agent is excessively low and the transfer of a drug may be inhibited when the film-forming agent is provided in an excess amount.

25        Examples of a water-soluble plasticizer in the form of a solid or a paste at  $20^{\circ}\text{C}$  at 1 atm, which can be

incorporated in the medicinal composition of the present invention, include a polymer or a copolymer of oxyalkylene such as oxyethylene or oxypropylene. A polymer or a copolymer having a larger polymerization  
5 degree is preferable. The oxyalkylene is preferably one having 1 to 4 carbon atoms, more preferably oxyethylene and/or oxypropylene.

A preferable polymerization degree of the polyoxyalkylene is preferably 70 or more in total. The  
10 polymerization degree is at least 80 or more if there is oxyethylene alone, and is at least 70 or more if there is oxypropylene alone. A preferable combination between oxyethylene and oxypropylene is such that the polymerization degree of oxypropylene is 30 to 80, the  
15 polymerization degree of oxyethylene is 35 to 400, and the sum of them is 70 or more.

Copolymers each having oxyethylene and oxypropylene are more preferable. Of those, one having a polyoxyethylene chain having a polymerization degree of  
20 100 to 300 and a polyoxypropylene chain having a polymerization degree of 25 to 80 is still more preferable.

In addition, the oxyalkylene polymer or copolymer may be independently incorporated or may be incorporated  
25 in combination with another one. However, when two or more of them are combined, the mixture of such a

combination should be kept in the form of a solid or paste at 20°C at 1 atm.

Of the combinations of the plasticizers, particularly preferable is a copolymer that contains  
5 only polyoxyethylene polyoxypropylene ether containing a polyoxyethylene portion having a polymerization degree of 140 to 180 and a polyoxypropylene portion having a polymerization degree of 20 to 40.

A preferable content of the plasticizer in the  
10 antifungal medical composition of the present invention is preferably 1 to 10% by weight in volume, more preferably 3 to 8% by weight in volume in total with respect to the whole amount of the medicinal composition. Furthermore, the content of the plasticizer is  
15 preferably 1 to 10 folds, more preferably 3 to 8 folds with respect to the content of the film-forming agent.

The antifungal composition of the present invention is represented by the general formula (1) described above. A compound in which R in the general formula (1)  
20 is represented by the general formula (2) is particularly preferable. Concretely, preferable compounds represented by the general formula (1) include  
(-)-(E)-[4-(2,4-dichlorophenyl)-1,3-dithioran-2-ylidene]-1-imidazolyl acetonitrile (Compound 1), (+)-  
25 (E)-[4-(2-chlorophenyl)-1,3-dithioran-2-ylidene]-1-imidazolyl acetonitrile (Compound 2), and lanoconazole.

Those compounds are known in the art, and thus the production methods and antifungal characteristics thereof have been already known in the art. JP 62-93227 A can be referred. An optically active substance or a  
5 racemic body can be used for such a compound. The optically active substance and the (-) body thereof are particularly preferable.

In addition, the "physiologically acceptable salt thereof" is not specifically limited as far as it is  
10 physiologically acceptable, and preferable examples thereof include: mineral acid salts such as hydrochloride, nitrate, sulfate, and phosphate; organic acid salts such as citrate, oxalate, lactate, and acetate; and sulfuric acid-containing acid chlorides  
15 such as mesilate and tosylate.

In terms of safety and solubility, hydrochloride is more preferable.

The antifungal compound represented by the general formula (1) and/or a physiologically acceptable salt  
20 thereof may be independently used alone or two or more different types thereof may be used in combination.

The content of the antifungal compound represented by the general formula (1) and/or the physiologically acceptable salt thereof in the antifungal medicinal  
25 composition of the present invention is preferably 0.1 to 30% by weight in volume, more preferably 0.5 to 15%

by weight in volume in total with reference to the total amount of the medicinal composition. The amount of the antifungal compound may be determined in consideration of its relation to the characteristics of a coating film  
5 generated.

The medicinal composition of the present invention may include any components generally used in dermatological external preparations in addition to the essential components described above.

10 Examples of such components include: hydrocarbons such as vaselline and microcrystalline wax; esters such as jojoba oil and spermaceti; triglycerides such as beef tallow and olive oil; higher alcohols such as cetanol and oleyl alcohol; fatty acids such as stearic acid and  
15 oleic acid; alcohols such as ethanol and isopropanol; polyvalent alcohols such as glycerine and 1,3-butanediol; water; nonionic surfactants; anionic surfactants; cationic surfactants; amphoteric surfactants; ethanol; thickeners such as carbopol;  
20 antiseptics; UV absorbers; antioxidizing agents; pigments; powders; and organic solvents.

Of those, components particularly preferable to be incorporated in the medicinal composition of the present invention include the anionic surfactants and the  
25 organic solvents.

In addition, the anionic surfactants are preferable

in that each of them has an action of accelerating the penetration of a drug into the nail or the hardened portion of the skin. Each of the anionic surfactants may be used alone or two or more of the anionic

5 surfactants may be used in combination.

Any of sulfate anionic surfactants and phosphorous anionic surfactants can be used as an anionic surfactant, and the anionic surfactant may have a polyoxyethylene chain or not. More preferably, alkyl sulfate which may  
10 have a polyoxyethylene group and/or alkyl phosphate which may have a polyoxyethylene group can be mentioned. Alkyl sulfate ester and/or polyoxyethylene-added alkyl triphosphate ester is/are still more preferable. A total number of added moles of the polyoxyethylene is  
15 particularly preferably 2 to 16. The alkyl group is preferably one having 10 to 20 carbon atoms. More specifically, preferable examples of the alkyl group include a lauryl group, a palmityl group, and a stearyl group. Particularly preferable examples of a  
20 combination of alkyl groups include a configuration containing both lauryl sulfate and tripolyoxyethylene (referred to as triPOE) (4) lauryl ether phosphate. Furthermore, preferable examples of the salts of those anionic surfactants include: alkali metal salts of  
25 sodium, potassium, and the like; organic amine salts such as monoethanol amine, triethanol amine, and



triethyl amine; ammonium salts; and salts of basic amino acids such as arginine and lysine. Of those, the alkyl metal salts are preferable and sodium salt is particularly preferable.

5           A preferable content of the anionic surfactant in the antifungal medicinal composition of the present invention is 0.5 to 10% by weight in volume, more preferably 1 to 5% by weight in volume in total with respect to the total amount of the medicinal composition.

10          Particularly preferable is a configuration containing 1 to 5 parts by weight of lauryl sulfate and 0.5 to 3 parts by weight of triPOE(4) lauryl ether phosphate with respect to 100 parts by volume of the antifungal medicinal composition of the present invention.

15           It is preferable that the antifungal medicinal composition of the present invention contain a polar organic solvent because of an increase in solubility of the antifungal compound represented by the above general formula (1).

20           Such an organic solvent is preferably one containing ketones, and examples thereof include one containing acetone or methyl ethyl ketone. In particular, an organic solvent containing methyl ethyl ketone is preferable.

25           A preferable content of the organic solvent in the antifungal medicinal composition of the present

invention is 50 to 90% by volume with respect to the total amount of the medicinal composition (hereinafter, the same will be applied). In this composition, a preferable content of the ketones is 10 to 50% by volume.

5 In addition, when an alcohol such as ethanol is additionally included, a preferable content of the alcohol is 20 to 60% by volume.

The medicinal composition of the present invention can be produced by treating the above essential  
10 components and arbitrary components in accordance with a usual method.

The medicinal composition thus obtained of the present invention forms a coating film having plastic property when it is applied to an application target.  
15 The coating film is in a viscous glass state. More specifically, the coating film itself is in the form of a solid but it is in a state of allowing the components to move inside the coating film.

The coating film is a film on which additional  
20 films can be applied. That is, for the purpose of continuing the treatment, when the medicinal composition of the present invention is administered again to form a coating film, the coating film previously applied and dried does not prevent the movement of a drug in the new  
25 coating to an affected area.

In addition, when the medicinal composition of the

present invention is applied to the affected area of the nail or skin, unlike a conventionally known lacquer preparation, the coating film is hardly removed in general but it can be removed by swelling means using an aqueous solvent and means for physically scratching the coating film. Concretely, under a humidity condition with water or the like, the coating film made of the medicinal composition of the present invention can be easily removed by scratching the coating film with an applied surfactant such as soap as required.

Furthermore, the coating film is in a glass state, so the movement of a drug from the coating film to the affected area can easily occur. As a result, the drug can be always supplied to the affected area at a predetermined concentration. Therefore, the drug availability rises as compared to the normal lacquer preparation. For this reason, the antifungal medicinal composition of the present invention can be effectively used as external application for the treatment of fungal diseases in the excessive keratinized portion of the skin and the thickened portion of the skin around the foot where the administration effect of the general antifungal medicinal composition for external application is hardly obtained. Consequently, the antifungal medicinal composition of the present invention can be used to the affected area of the

excessive keratinized portion of the nail or skin, or the thickened skin portion around the foot.

Furthermore, fungi to be targeted with the antifungal medicinal composition of the present invention include Trichophyton (Trichophyton), a  
5 causative organism of candidiasis (Candida), a causative organism of cryptosporidiosis (cryptosporidium), and yeasts (Aspergillus).

The medicinal composition of the present invention  
10 can be produced by means of the general procedures. A preferable production example in a preferred embodiment will be described below.

For the production of an antifungal medicinal composition including: (1) one or two or more selected  
15 from the group consisting of ethyl cellulose, hydroxypropyl methylcellulose phthalate, and an acrylic resin emulsion; (2) a polymer or copolymer composed of oxyethylene and/or oxypropylene, and (3) an antifungal compound represented by the general formula (1) and/or a  
20 physiologically acceptable salt thereof, alkyl sulfate which may have a polyoxyethylene group and/or alkyl phosphate which may have a polyoxyethylene group and the polymer or copolymer composed of oxyethylene and/or oxypropylene are dissolved in a solvent containing  
25 acetone or methyl ethyl ketone. In this solution, furthermore, the one or two or more selected from the

group consisting of ethyl cellulose, hydroxypropyl  
methylcellulose phthalate, and an acrylic resin emulsion  
is/are added and dissolved, followed by adding and  
dissolving the antifungal compound represented by the  
5 general formula (1) and/or the physiologically  
acceptable salt thereof. The production according to  
such a method allows the pharmaceutical manufacturing of  
the antifungal composition represented by the general  
formula (1) in a stable manner without causing crystal  
10 even in the case of using a water-containing solvent.

Consequently, a preferable production method of the  
antifungal medicinal composition of the present  
invention can be provided.

#### 15 Examples

Hereinafter, the present invention will be  
described concretely with reference to examples.  
However, the present invention is not limited to these  
examples.

20 Furthermore, the abbreviations in each of examples  
and tables represent the following.

HP-55: Hydroxypropyl methylcellulose phthalate

Pluronic F-68: Polyoxyethylene (160)

polyoxypropylene (30) glycol

25 Macrogol 200: Polyethylene glycol 200

SDS: Sodium lauryl sulfate

TLP-4: Tripolyoxyethylene (4) lauryl ether sodium phosphate

<Example 1>

5           According to the formulation shown in Table 1 below,  
the antifungal medicinal composition of the present  
invention was produced. The components a were stirred  
and solubilized. Then, the component b was added and  
solubilized, and the component c was further added and  
10 solubilized, followed by the addition of the component d.  
Subsequently, the component e was added in order to  
adjust the pH of the mixture to pH 6, followed by the  
addition of the component f to make the total volume up  
to 100 ml. Consequently, an antifungal medicinal  
15 composition was obtained.

Table 1

	Components	
a	Methyl ethyl ketone	35mL
	Ethanol	35mL
	Pluronic F-68	5g
	Sodium lauryl sulfate	2g
b	Ethyl cellulose	1g
c	Compound 1	2g
d	Water	15g
e	Phosphoric acid	Optimum dose
f	Ethanol	Making total volume up to 100 ml

## &lt;Examples 2 to 4&gt;

The components a to f were added in the same order  
5 as that of Example 1 to prepare antifungal compositions  
of the present invention shown in Table 2 below. In  
addition, as shown in Table 2, comparative examples of  
the comparable technologies which did not belong to the  
antifungal medicinal composition of the present  
10 invention were also prepared.





## &lt;Example 5&gt;

The antifungal medicinal compositions for external application of the present invention of Examples 1 to 4 and the antifungal medicinal compositions for external application of Comparative Examples 1 to 6 were investigated for characteristics of a coating film resulting from the application on nails.

As for the characteristics of the coating film, evaluation items were defined as: a time period (second) from the drying after application to the film formation; the condition of the coating film at 12 hours from the application; and the removability of the coating film with water at 12 hours from the application, respectively.

15 The criteria for the coating film conditions were

◎: no removal of the coating film;

○: partial removal of the coating film;

△: almost half removal of the coating film; and

×: more than half removal of the coating film.

20 The criteria for the removability were

◎: easily washing out the coating film;

○: requiring scouring to wash out the coating film;

and

×: impossible to wash out the coating film by means of running water.

The results are shown in Table 3. The results show

that the antifungal external application of the present invention is excellent in retaining the coating film while the coating film can be easily removed through water washing

5

Table 3

Sample	Drying time	Conditions after 12 hours	Washing efficiency
Example 1	45 seconds	◎	◎
Example 2	40 seconds	◎	◎
Example 3	65 seconds	◎	◎
Example 4	67 seconds	◎	◎
Comparative Example 1	40 seconds	×	◎
Comparative Example 2	50 seconds	◎	×
Comparative Example 3	50 seconds	×	○
Comparative Example 4	60 seconds	×	○
Comparative Example 5	60 seconds	◎	×
Comparative Example 6	50 seconds	◎	×

## &lt;Example 6&gt;

The antifungal medicinal compositions for external preparation of Examples 3 and 4 described above and the antifungal medicinal compositions for external preparation of Comparative Examples 5 and 6 described above were investigated in terms of the drug release

10

from their coating films formed using a Franz type diffusion cell.

As shown in Fig. 1, 200  $\mu$ l of a pharmaceutical agent were dropped onto a PET sheet (reference numeral 1) to form a coating film and then a dialysis membrane (reference numeral 2) was laminated on this sheet. The dialysis membrane was directed to a receptor and then mounted on the Franz type diffusion cell. Subsequently, the receptor was filled with 0.01 N hydrochloric acid and samples were then obtained from the receptor at regular time intervals to determine the level of the pharmaceutical agent in the liquid in the receptor using HPLC.

The results are shown in Fig. 2. As is evident from Fig. 2, the compositions of Examples 3 and 4 have excellent characteristics of drug release compared with those of Comparative Examples 5 and 6.

In consideration of those results together with the results of the above examples, it is found that the antifungal medicinal composition of the present invention keeps a drug-storing film intact over an extended time period and releases the drug from the film effectively to enhance the therapeutic effects of the drug, while it retains the ability of being easily removed when it is needed to be removed.

<Example 7> In Vitro Test for Pharmacometrics

A cylindrical silicone ring was fixed on the surface of nail plate (human) with a silicon bond, and the resultant was placed on a nutrient-free agar medium  
5 containing  $2 \times 10^5$ /ml of conidiospores of *Trichophyton mentagrophytes*, followed by incubating the medium at 28°C for 7 days.

After incubation, the growth of bacteria on the nail bed side was confirmed and then each agent, 5l, was  
10 administered in the cylindrical ring. After administration, the resultant was incubated at 28°C for 7 days and then the nail was removed from the medium, followed by lightly scratching the nail bed side with a needle spreader.

15 On this occasion, the nail waste caused was seeded on a Sabouraud's agar medium and then incubated at 28°C for 14 days, followed by confirming the bacterial growth. The nail, which did not show the bacterial growth, was recognized as bacteria negative. The ratio (%) of the  
20 bacteria negative nail waste was determined. The results are shown in Table 4.

As is evident from the results, the antifungal medicinal composition of the present invention exerts excellent abilities of storing and releasing a drug and  
25 also exerts excellent effects on fungal diseases which are hardly cured by means of the general external

application therapy owing to the inhibition of thick keratin such as a nail.

Table 4

	Example 2	Comparative Example 2	Comparative Example 4
Name of drug	Compound 1	Compound 1	Compound 1
Level of drug	5%	5%	5%
Bacterial negative ratio (n = 6)	100%	33.3%	33.3%

5

<Examples 8 and 9>

The components a to f (except e) were added in the same order as that of Examples 1 to 4 to prepare the antifungal medicinal compositions (Examples 8 and 9) of the present invention shown in Table 5 below. In addition, as shown in Table 5, the antifungal medicinal compositions of Comparative Examples 7 to 9 were prepared.

Those compositions were investigated for drying time and conditions and washing efficiency after 12 hours. The results were shown in Table 6.

Table 5

Compo- nents		Example 8	Example 9	Compara- tive Example 7	Compara- tive Example 8	Compara- tive Example 9
a	Methyl ethyl ketone	35mL	35mL	35mL	35mL	35mL
	Pluronic F-68	5g	3g			5g
	SDS	2g	0g	2g	0g	2g
b	Ethyl cellulose	1.5g	0g	1.5g	0g	1.5g
	Ethy lacrylate/ methyl methacrylate copolymer dispersion (solid)		1.5g		1.5g	
c	Lanocanazole	2.0g	2.0g	2.0g	2.0g	0g
d	Purified water	15g	15g	15g	15g	15g
a, f	Absolute ethanol	Optimum dose	Optimum dose	Optimum dose	Optimum dose	Optimum dose
	Total	100mL	100mL	100mL	100mL	100mL

Table 6

Sample	Drying time	Conditions after 12 hours	Washing efficiency
Example 8	40 seconds	⊙	⊙
Example 9	50 seconds	⊙	⊙
Comparative Example 7	40 seconds	⊙	x
Comparative Example 8	50 seconds	⊙	x
Comparative Example 9	40 seconds	⊙	x

## &lt;Example 10&gt;

The in vitro effects of the antifungal medicinal composition of the present invention were evaluated by the same way as that of Example 7, except that  
5 incubation was carried out at 28°C for 14 days. The results are shown in Table 7.

Therefore, it is evident that the medicinal composition of the present invention has an excellent antifungal action. In addition, it is also found that  
10 the compounds represented by the general formula (1), in particular Compound 1, are particularly preferable for a pharmaceutical preparation.

Table 7

	Example 1	Example 8	Comparative Example 9
Name of drug	Compound 1	Laniconazole	None
Level of drug	2%	2%	None
Bacterial negative ratio (n = 6)	100%	83.3%	0%

15

## &lt;Example 11&gt;

The medicinal composition of the present invention was prepared by the same way as that described above, except that the concentration of Compound 1 was changed.

20

Table 8

	Components	
a	Methyl ethyl ketone	35mL
	Ethanol	35mL
	Pluronic F-68	5g
	Sodium lauryl sulfate	2g
b	Ethyl cellulose	1g
c	Compound 1	5g
d	Water	15g
e	Phosphoric acid	Optimum dose
f	Ethanol	Making total volume up to 100 ml

## &lt;Example 12&gt;

The medicinal composition of the present invention  
 5 was prepared by the same way as that described above,  
 except that the concentration of Compound 1 was changed.

Table 9

	Components	
a	Methyl ethyl ketone	35mL
	Ethanol	35mL
	Pluronic F-68	5g
	Sodium lauryl sulfate	2g
b	Ethyl cellulose	1g
c	Compound 1	2.5g
d	Water	15g
e	Phosphoric acid	Optimum dose
f	Ethanol	Making total volume up to 100 ml

## 10 &lt;Example 13&gt;

The medicinal composition of the present invention



was prepared by the same way as that described above,  
except that the concentration of Compound 1 was changed.

Table 10

	Components	
a	Methyl ethyl ketone	35mL
	Ethanol	35mL
	Pluronic F-68	5g
	Sodium lauryl sulfate	2g
b	Ethyl cellulose	1g
c	Compound 1	1.25g
d	Water	15g
e	Phosphoric acid	Optimum dose
f	Ethanol	Making total volume up to 100 ml

5

## &lt;Example 14&gt;

Reference Examples, in which the medicinal  
compositions of Examples 11 to 13 described above and  
Compound 1 of Example 11 were substituted with ethanol  
10 respectively, were subjected to a primary skin  
irritation test.

That is, the backs of rabbits (New Zealand White  
species, six animals per group) were dehaired to form 6  
areas of 3 cm x 3 cm. On each of those areas, a lint  
15 cloth soaked with 0.5 ml of the sample was pasted and  
then covered with Parafilm and a bandage, followed by  
conducting a 24-hour closed patch. One of the areas was  
not patched and treated. At one hour after removal of

the patch, a skin reaction was observed in terms of two items: (1) erythema and crust formation and (2) edema formation.

5 The erythema and crust formation were evaluated on the basis of the following evaluation criteria/

Score 0: no erythema, Score 1: minimum erythema, Score 3: clear erythema, and Score 4 middle to strong erythema, mild crust formation in erythema with strong dark red.

10 The edema formation was evaluated on the basis of the following criteria.

Score 0: no edema, Score 1: minimum edema; Score 2, clear edema, Score 3: medium edema, and Score 4: strong edema.

15 The results show that any of the sampled areas was Score 0 for each of (1) erythema and crust formation and (2) edema formation. As is evident from those results, the safety in dermatological external application of the present invention was confirmed.

20

#### Industrial Applicability

According to the present invention, a medicinal composition useful for external application in the  
25 treatment of a fungal infection reaching the lower part of a thick keratin layer can be provided.